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IN 1975 CDH DETECTED THE PRESENCE OF ORGANIC SOLVENTS AND PHTHALATE ESTERS IN ISOLATED WELL WATER SAMPLES, WHICH LEAD TO THE DEVELOPMENT OF A SERIES OF PROGRAMS TO MONITOR WATER WELL AND SURFACE WATER SITES INCLUDING THE RMA AND OFFPOST SITES TO THE NORTH AND WEST OF THE RMA PERIMETER. THE REVISION 360 DEGREE PROGRAM WAS INITIATED IN JANUARY 1976. ANOTHER REVISION OF THIS PROGRAM WAS INSTITUTED IN NOVEMBER 1976. THIS NEW PROGRAM, WAS IDENTIFIED AS REVISION II-360 DEGREE PROGRAM. THIS PROGRAM WAS NOT EFFICIENT. AS A RESULT A REVISED OFFPOST GROUNDWATER MONITORING PROGRAM WAS DEVELOPED, AND IS REFERRED TO AS THE REVISION III-360 DEGREE PROGRAM.

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LITIGATION TECHNICAL SUPPORT AND SERVICES

ROCKY MOUNTAIN ARSENAL

CONTINUED OFF-POST GROUND WATER MONITORING PROGRAM
(REVISION III - 360° MONITORING PROGRAM)

FEBRUARY 1986

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
PROGRAM MANAGER'S OFFICE FOR ROCKY MOUNTAIN ARSENAL

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LITIGATION TECHNICAL SUPPORT AND SERVICES

ROCKY MOUNTAIN ARSENAL

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

PREPARED FOR

PROGRAM MANAGER'S OFFICE FOR

ROCKY MOUNTAiN ARSENAL CLEANUP

87016205

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CONTINUED OFFPOST GROUND WATER MONITORING PROGRAM (REVISION III-360° MONITORING PROGRAM) ROCKY MOUNTAIN ARSENAL

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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Englewood, (Denver), Colorado 80112

February 1986

Prepared for:

Office of the Program Manager
RMA Contamination Cleanup
Aberdeen Proving Ground, Maryland 21010

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CONTINUED OFFPOST GROUND WATER MONITORING PROGRAM
(REVISION III-360° MONITORING PROGRAM)
ROCKY MOUNTAIN ARSENAL

HISTORICAL 360° PROGRAM

In May of 1975, two water sampling plans were initiated at Rocky Mountain Arsenal (RMA). One plan was in response to a series of lawsuits against RMA and Shell Chemical Company (Shell) by residents north of RMA complaining of contaminated domestic water supplies. The other plan was in response to a Cease and Desist Order issued by the State of Colorado ordering that RMA and Shell stop contaminating Colorado state waters. Two months later, these two plans were consolidated into one, resulting in the establishment of 42 sampling sites on and off RMA. These combined sampling plans were designated the original 360° Program.

The design and implementation of this sampling scheme was carried out in coordination with the Project Manager Chemical Demilitarization Installation Restoration (PM-CDIR) and with the cooperation of Shell and the Colorado Department of Health (CDH). It was intended that these 42 sites would be sampled on a monthly basis for the 15 parameters shown in Table 1.

In October 1975, the CDH detected the presence of organic solvents and phthalate esters in isolated well water samples. The discovery of these organic compounds in well samples led to a major shift in the water quality monitoring program. It was felt that because these newly detected compounds are associated with materials available to the public, these contaminants detected in ground water from RMA could come from sources off RMA. The initial sampling program was restricted to the central and northen part of RMA, as well as offpost to the north. In order for RMA to unequivocally declare what had been contributed to ground water contamination, the antecedent water quality flowing on to RMA had to be determined. A program was developed to monitor water well and surface water sites including the RMA and offpost sites to the north and west of the RMA perimeter. This program is currently referred to as the Revison I-360° Program.

Table 1. Original 360° Program Analytical Schedule

Analyte	Reported Lower Level or Range of Values	Units
DIMP	10	µg/l
DCPD	30	µg/l
DBCP	0.2	µg/l
Calcium	0.2	mg/l
Chloride	20	mg/l
Fluoride	0.2	mg/l
Hardness (Total)	20	mg/l
Alkalinity (Total)	10	mg/l
Potassium	2.0	mg/l
Magnesium	0.5	mg/l
Sodium	20	mg/l
Nitrate (Total)	0.5	mg/l
Sulfate	50	mg/l
pH	0-14	units
Specific Conductance	0-10,000	µmhos/cm

Source: ESE, 1984.

The Revision I-360° Program, initiated in January 1976, included 124 surface water sites and ground water monitoring wells on or adjacent to RMA, and 24 private wells and 5 offpost surface water sites selected by the Tri-County District Health Department (TCDHD). Water samples from onpost wells were collected monthly and analyses were performed by CDH and Shell, as well as RMA. The offpost samples were collected quarterly and analyzed by all three parties for the same parameters as onpost sites.

Another revision of this program was instituted in November 1976, after a project review indicated that the sampling methods used required better quality control (QC). For many of the wells in use under the original program, the bore logs were incomplete and in some cases wells were not properly maintained. In other instances, sampling wells were so close to each other as to be redundant.

This new program, identified as the Revision II-360° Program, required 55 well sites and 12 surface water sites on RMA to be sampled and analyzed by the Army on a quarterly basis. Eleven monitoring wells, designated the Army OP-series wells, are located outside the RMA boundary and were also sampled by the Army. The 24 privately-owned wells and offpost surface water sites sampled by TCDHD, and analyzed by CDH and the Army, remained the same. Wells included in the offpost portion of the Revision II-360° Program are listed in Table 2.

Since the closing of Shell's facilities at RMA, the Army, Shell, CDH, and TCDHD have assumed responsibility for carrying out the tasks of sampling and analysis. The Army has been responsible for program management, data management, program review and data evaluation.

REVISED MONITORING PROGRAM

A consumptive use sampling program was implemented during the period of December 1984 through January 1985. This Consumptive Use-Phase I sampling effort involved collection of 117 samples from existing wells completed in both alluvial and bedrock aquifers, as shown in Figure 1. Subsequently, a Consumptive Use-Phase II Program was developed for the

Table 2. Offpost Revision II-360° Program Wells (Page 1 of 3)

Identification Number	Owner Address	Location
IV	Gerald Sitzman 13990 E. 136th St.	T1S, R66W, S19
VI	Victor Amdahl 16291 E. 136th St.	T1S, R66W, S20
VIII	Tom Whitmill 12240 Peoria	T1S, R67W, S36
XII	Jack Salthouse 12201 E. 120th	T1S, R67W, S1
XIX	Paul Harrison 10371 E. 123rd Ave.	T1S, R67W, S34
XX	Suburban Gravel 11721 Brighton	T2S, R67W, S3
XXI	G. P. Murray 11010 Havana	T2S, R67W, S11
XXIV	Robert Redding 12600 N. Sable	T1S, R66W, S31
XXVIII	Denver Products Terminal 8581 E. 96th	T2S, R67W, S16
XXXII	Sam Dean 8610 Verbena	T2S, R67W, S28
LIIII-B	Thomas Smaldone 9610 Peoria	T2S, R67W, S13
LIV	Thomas Smaldone 9610 Peoria	T2S, R67W, S13
LV	Jessie Powers 9339 E. 96th	T2S, R67W, S15
LVII	DM & H Cattle 10700 Peoria #1	T2S, R67W, S12
LVIII	Wilbert Wagoner 11810 E. 136th	T1S, R67W, S26

Table 2. Offpost Revision II-360° Program Wells (Page 2 of 3)

Identification Number	Owner Address	Location
LVIX	Mr. Donate 12930 E. 104th	T2S, R67W, S12
LXIII	Mr. Kallsen 11850 Chambers	T2S, R67W, S5
LXIV	Mr. Murata 14151 Potomac	T1S, R67W, S4
C	S.A.C.W.S.D. 84th & Quebec	T2S, R67W, S28
CI	Richard Strab 7711 E. 81st Ave	T2S, R67W, S28
CII	Albert Amador, Jr. 7425 E. 86th Ave.	T2S, R67W, S28
CIII	Owner Unknown 8340 Pontiac	T2S, R67W, S29
CIV	Owner Unknown 8356 Syracuse	T2S, R67W, S28
BOLLER	Industrial Realty Corp.	T2S, R67W, S12 105th & Hwy 2
OP 304	Army 37304	T2S, R67W, S14
OP 305	Army 37305	T2S, R67W, S14
OP 306	Army 37306	T2S, R67W, S14/23 Boundary
OP 307	Army 37307	T2S, R67W, S14/23 Boundary
OP 308	Army 37308	T2S, R67W, S13
OP 309	Army 37309	T2S, R67W, S14/13 Boundary

Table 2. Offpost Revision II-360° Program Wells (Page 3 of 3)

Identification Number	Owner Address	Location
OP 310	Army 37310	T2S, R67W, S14/13 Boundary
OP 311	Army 37311	T2S, R67W, S13
OP 312	Army 37312	T2S, R67W, S13/34
OP 313	Army 31313	T2S, R67W, S14
OP 58	Army 37058	T2S, R67W, S14

Source: ESE, 1985.

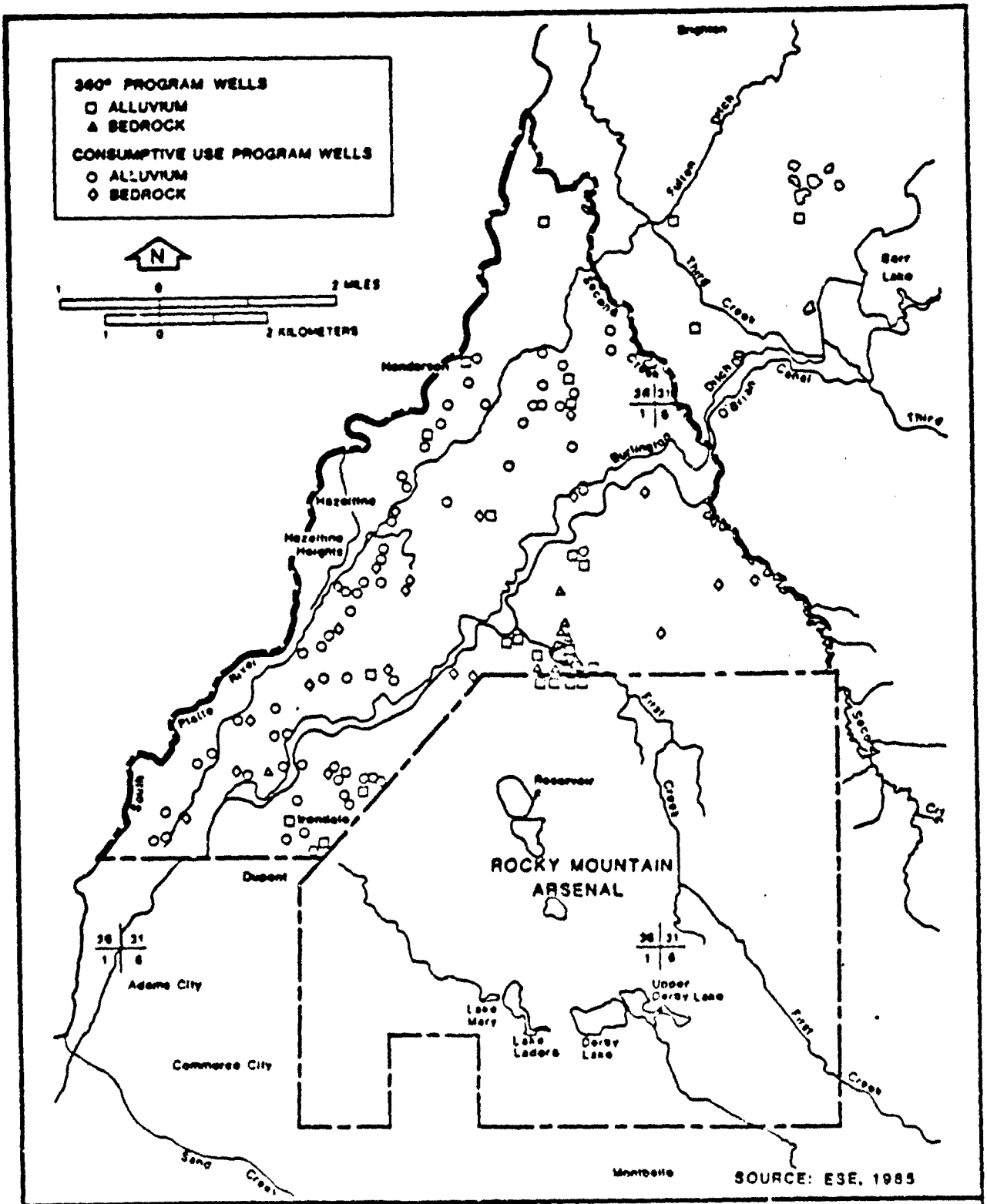

Figure 1
GROUND WATER SAMPLING LOCATIONS
CONSUMPTIVE USE PHASE I PROGRAM

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

area determined to be most contaminated. Samples were collected from an additional 40 existing alluvial and bedrock wells during September and October 1985, as shown in Figure 2.

The Consumptive Use ground water sampling efforts have refined understanding of potential contaminant migration pathways and have emphasized a number of deficiencies in the earlier monitoring programs. Areal coverage hydraulically downgradient of RMA during the Revision II-360° Program was relatively sparse, and the private wells sampled often lacked appropriate well construction data. Well depth, screened interval, and aquifer characteristics were unavailable for most private wells. In addition, the Consumptive Use sampling results have indicated the presence of compounds previously not determined during the earlier Revision II-360° Program.

As a result, a revised offpost ground water monitoring program has been developed, and is referred to as the Revision III-360° Program. Sampling locations for the Revision III-360° Program are presented in Plate 1. Twenty-nine new monitoring wells have been installed throughout the study area. Special emphasis has been placed on delineating contaminant migration pathways associated with zones of enhanced permeability (coarse paleochannels) within the alluvial aquifer. These monitoring wells will provide additional stratigraphic and hydrologic characterization of the alluvial and bedrock aquifers, and will serve as the nucleus of the revised ground water quality monitoring program. An expanded suite of analytical parameters has also been developed to further delineate contaminant distributions.

In order to provide continuity with historical monitoring programs, ten Revision II-360° Program wells (Privately-owned and OP-Series) and four Army Offpost monitor wells (M-Series) were selected to supplement the 29 Offpost Contamination Assessment Program (Offpost CA E-Series) monitoring wells recently completed in the offpost study area (Plate 1). Together, these 43 wells will comprise a ground water monitoring network to be sampled on a quarterly basis and analyzed for the parameters listed in Table 3.

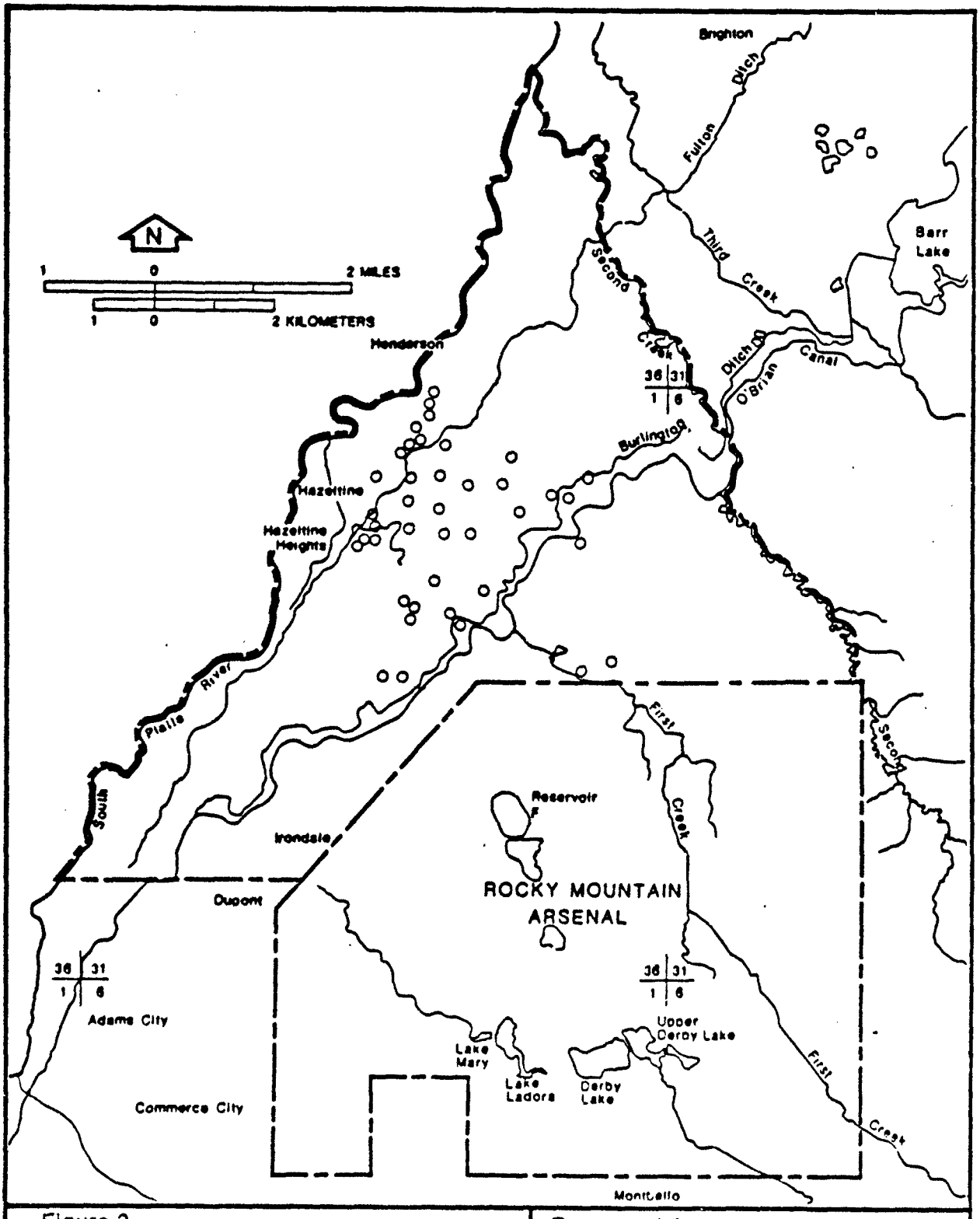

Figure 2
LOCATIONS OF WELLS SAMPLED,
RMA CONSUMPTIVE USE
PHASE II PROGRAM
SOURCE: ESE, 1986

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

Table 3. Analytical Parameters-Revision III 360° Monitoring Program

Aldrin	Chloride
Endrin	Fluoride
Dieldrin	Cadmium*
Isodrin	Chromium*
HCCPD*	Copper*
p,p'-DDT*	Lead*
p,p'-DDE*	Zinc*
DBCP	Mercury*
DCPD	Arsenic*
MIBK*	Calcium*
DIMP	Magnesium*
DMMP*	Sodium*
PCPMS	Potassium*
PCPMSO	Nitrate*
$PCPMSO_2$	Nitrite*
Dithiane	Sulfate*
Oxathiane	Alkalinity*
Toluene	Conductivity
Benzene	pH
Xylene (o-,p-)	
Xylene (m-)	
Ethylbenzene*	
Chlorobenzene	
Methylene chloride*	
Chloroform	
Carbon Tetrachloride	
1,2-Dichloroethylene	
Trichloroethylene (TCE)	
Tetrachloroethylene	
1,1-Dichloroethylene*	
1,1-Dichloroethane*	
1,2-Dichloroethane*	
1,1,1-Trichloroethane*	
1,1,2-Trichloroethane*	

* Parameters added after First Quarter Sampling.

Source: ESE, 1985.

The Revision III-360° Program wells were selected on the basis of:

- o Areal distribution;
- o Well completion;
- o Lithology;
- o Observed contamination; and
- o Historical record.

Further discussion of the selection criteria for incorporating 14 wells from previous programs is provided below. The locations of these wells are plotted in Figure 3. Existing well construction details are provided in Table 4. Historical data for the 360° Program wells included in the monitoring network are listed in Appendix A.

ARMY OFFPOST MONITORING WELLS - (OP SERIES)

Army wells OP305, OP307, OP308, OP309, OP312, and OP313 were selected for incorporation into the Revision III-360° Program to allow characterization of variable ground water quality along a primary migration pathway. These wells are completed in the alluvial aquifer and have exhibited varying degrees of contamination during past sampling efforts. Well construction and lithologic details are available and are presented in Table 4. Six of the ten OP Series wells sampled during the Phase I Consumptive Use Study will be included in the Revision III monitoring network. These six OP wells were selected on the basis of their areal distribution with respect to Offpost CA monitoring wells and the contaminant concentrations detected during the Consumptive Use-Phase I sampling program.

ARMY OFFPOST MONITORING WELLS - (M-SERIES)

Although the Army well M-Series were not sampled historically as part of the 360° Program, four wells were selected for inclusion in the Revision III Monitoring Program based on areal location and construction. These wells are located in areas of insufficient data, and are required to further characterize migration of contaminants in Sections 12, 13, and 22. Well 37320 is completed in the alluvial aquifer along a channel in the bedrock surface which is suspected to provide a primary pathway

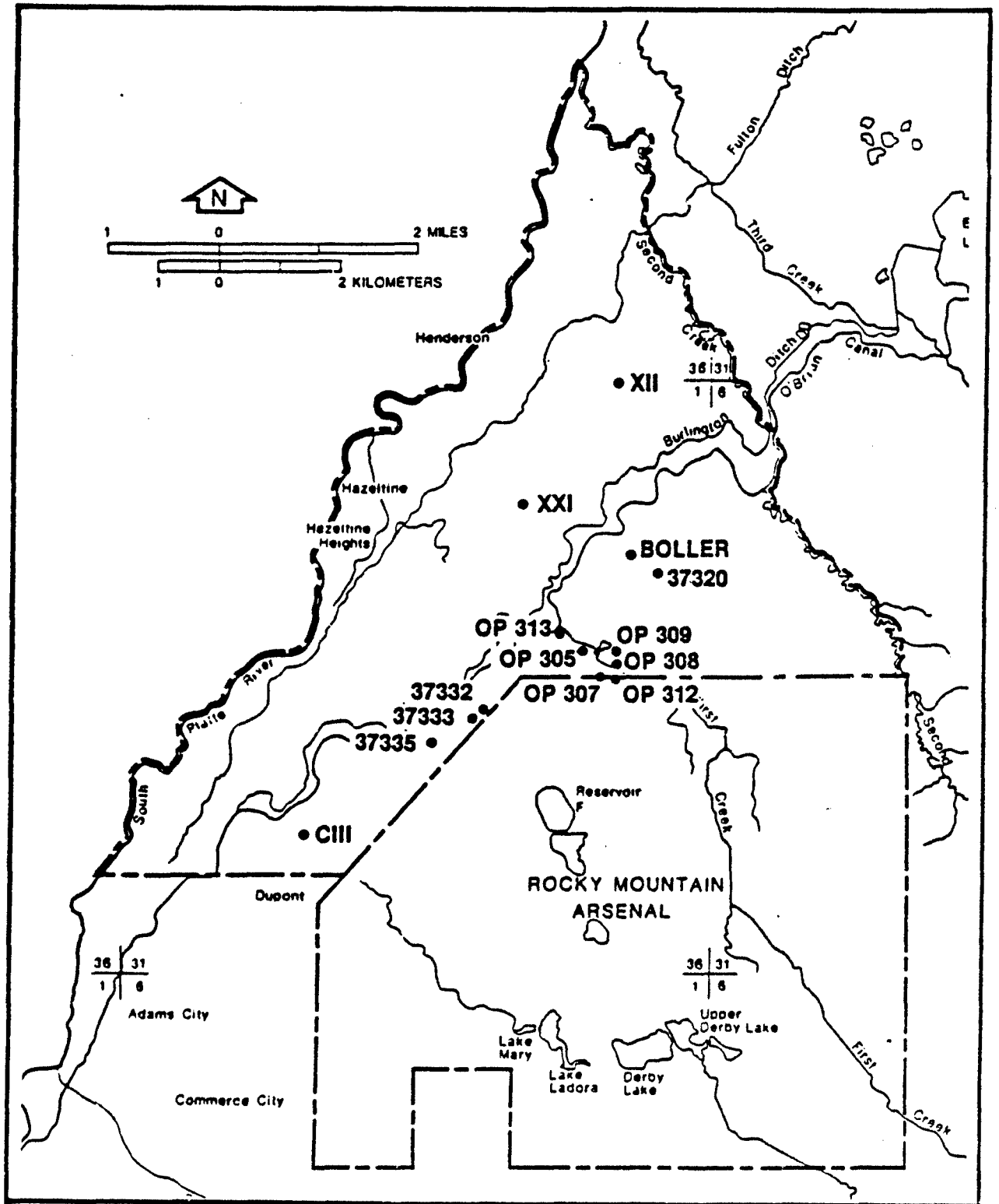

Figure 3
REVISION II-360° WELLS AND ARMY M—SERIES WELLS SELECTED FOR CONTINUED MONITORING
SOURCE: ESE, 1985

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

Table 4. Revision III-360° Monitoring Program--Former Revision II-360° Monitoring Program Wells

Site ID Number	Well Number	Location Coordinates UTM Zone 13 North	East	Aquifer	Ground Level Elevation	Well Completion Depth (ft BGL)*	Screened Interval (ft BGL)*	Depth to Bedrock (ft BGL)*
37305	OP305	4413560	512600	Alluvial	5118.43	29.0	--	27.0
37307	OP307	4413210	512900	Alluvial	5147.65	21.5	--	20.5
37308	OP308	4413320	513170	Alluvial	5127.60	21.5	--	20.5
37309	OP309	4413570	513200	Alluvial	5123.11	24.0	--	23.0
37312	OP312	4413190	513340	Alluvial	5138.33	15.0	--	13.5
37313	OP313	4413940	512330	Alluvial	5108.94	30.0	--	28.8
37320	M-40A	4414846	513615	Alluvial	~5123.00	38.00	~22.8-32.4	34.7
37332	OP332	4412300	510750	Alluvial	5133.6	54.1	46.7-51.4	50.9
37333	OP333	4412100	510550	Alluvial	~5128.0	50.4	38.4-47.7	47.1
37335	OP335	4412050	509900	Alluvial	~5123.0	55.5	38.2-52.6	50.7
BOLLER	BOLLER	4415200	513460	Alluvial	~5118.00	--	--	NA
XII	XII	4418000	513240	Alluvial	~5060.00	44.0	38-44	NA
XXI	XXI	4419380	511670	Alluvial	~5080.00	--	--	NA
CIII	CIII	4410660	508170	Alluvial	~5130.00	65.00	40-65	NA

* BGL - Below Ground Level.

Source: ESE, 1986.

for migrating contaminants. Wells 37332, 37333, and 37335 are completed in a similar channel which has historically been reported as a migration pathway.

PRIVATELY OWNED CONSUMPTIVE USE WELLS

Well CIII was selected to provide supplemental data to assist in identifying potential contamination from chlorinated aliphatic solvents in the Irondale area. Samples collected from this well during the Consumptive Use-Phase I sampling effort contained a concentration of trichloroethylene slightly above the detection limit (3 µg/l). Construction details and lithology were obtained from the Colorado State Engineer's Office.

Well XII was selected in order to extend the area of monitoring coverage to the north. Samples collected from this well during the Consumptive Use-Phase I sampling effort indicated the absence of organic contaminants. Construction details were obtained from the Colorado State Engineer's Office.

Wells XXI and Boller were selected in order to continue their historical water quality data base. Information on construction of these two wells is unavailable, although they appear to be completed in the alluival aquifer. Both wells, XXI and Boller, are located near Offpost CA monitoring wells. A large historical data base exists for these two wells, and continued monitoring will allow comparison of future analytical data to historic sampling data obtained during the previous 360° Program.

OFFPOST CONTAMINATION ASSESSMENT MONITORING WELLS - (E-SERIES)

Of the 29 new monitoring wells, 28 were installed between September 1985 and November 1985. The final well, E-24 will be installed in January 1986. Installation was performed according to the Offpost Contamination Assessment Technical Plan (ESE, 1985b).

Rationale for each of the 29 monitoring wells is discussed in detail in Section 3.2.1 of the Technical Plan. Several program adjustments were

made to the proposed plan as a result of conditions encountered during drilling. Two planned wells, E-2 and E-14, were abandoned because saturated alluvium was not present overlying local bedrock highs at the planned locations. One additional well, E-31, was installed in order to compensate for the two wells not completed. In addition, minor adjustments were made in the planned locations of many of the wells as a result of site access problems, utility rights-of-way considerations, and additional information provided by the SACWSD.

Boreholes for well installation in the alluvial aquifer were drilled using hollow-stem auger drilling techniques. Split-spoon soil samples were collected continuously from the surface to a depth of 3 meters (m), and subsequently at 1.5 m intervals or at major lithologic changes until bedrock refusal. In the boreholes for Wells E-23 and E-26, the presence of cobbles and formation collapse made hollow-stem drilling techniques impossible. Boreholes were advanced by rotary drilling and driving 8-inch (in) ID welded steel casing to prevent the borehole from collapsing. Soil samples were collected in these boreholes as described above for the hollow-stem auger borings.

For monitoring Well E-24, which was installed in the Denver Formation, the borehole was advanced to bedrock by rotary drilling and driving casing. The bedrock was drilled with a diamond-bit core barrel to provide continuous core samples of the Denver Formation, after which the borehole was reamed to a diameter of 8-in to the completion depth.

Offpost CA monitoring wells were constructed using 4-in ID Schedule 40 PVC screen and casing. Screened intervals of alluvial wells extended through the entire saturated thickness above bedrock. The screened interval of Well E-24 encompasses the entire saturated thickness of the first transmissive water bearing unit encountered in the Denver Formation. Well construction details are illustrated on Figures 4 and 5. Wells were constructed using PVC screens with 0.020-in slots (20-slot). The annular space surrounding the screen was sand-packed with 10 to 20 mesh silica sand. Locations of the Offpost CA monitoring wells are plotted in Figure 6, and construction details for individual wells are listed in Table 5.

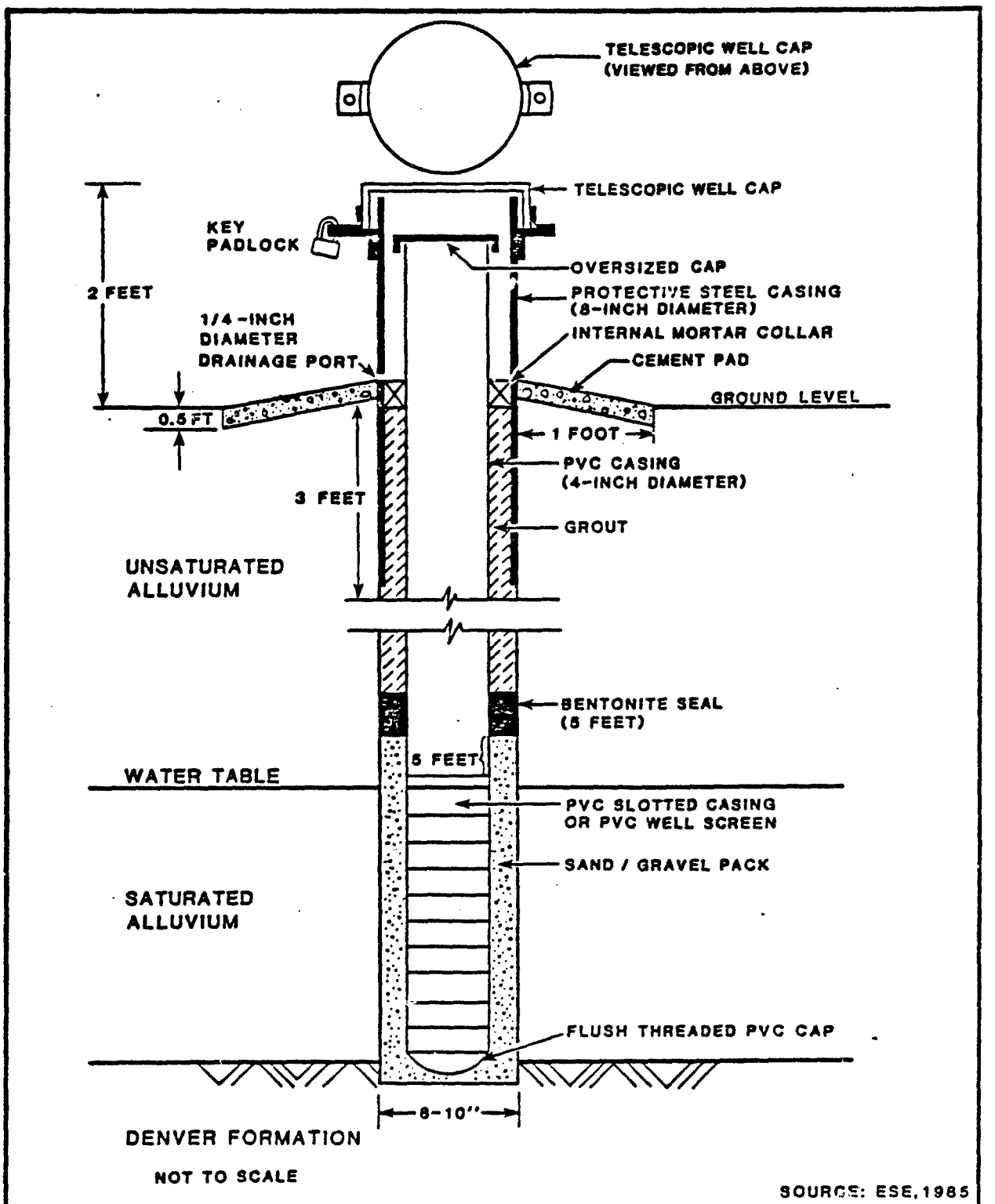

Figure 4
SHALLOW (ALLUVIAL) MONITOR WELL CONSTRUCTION

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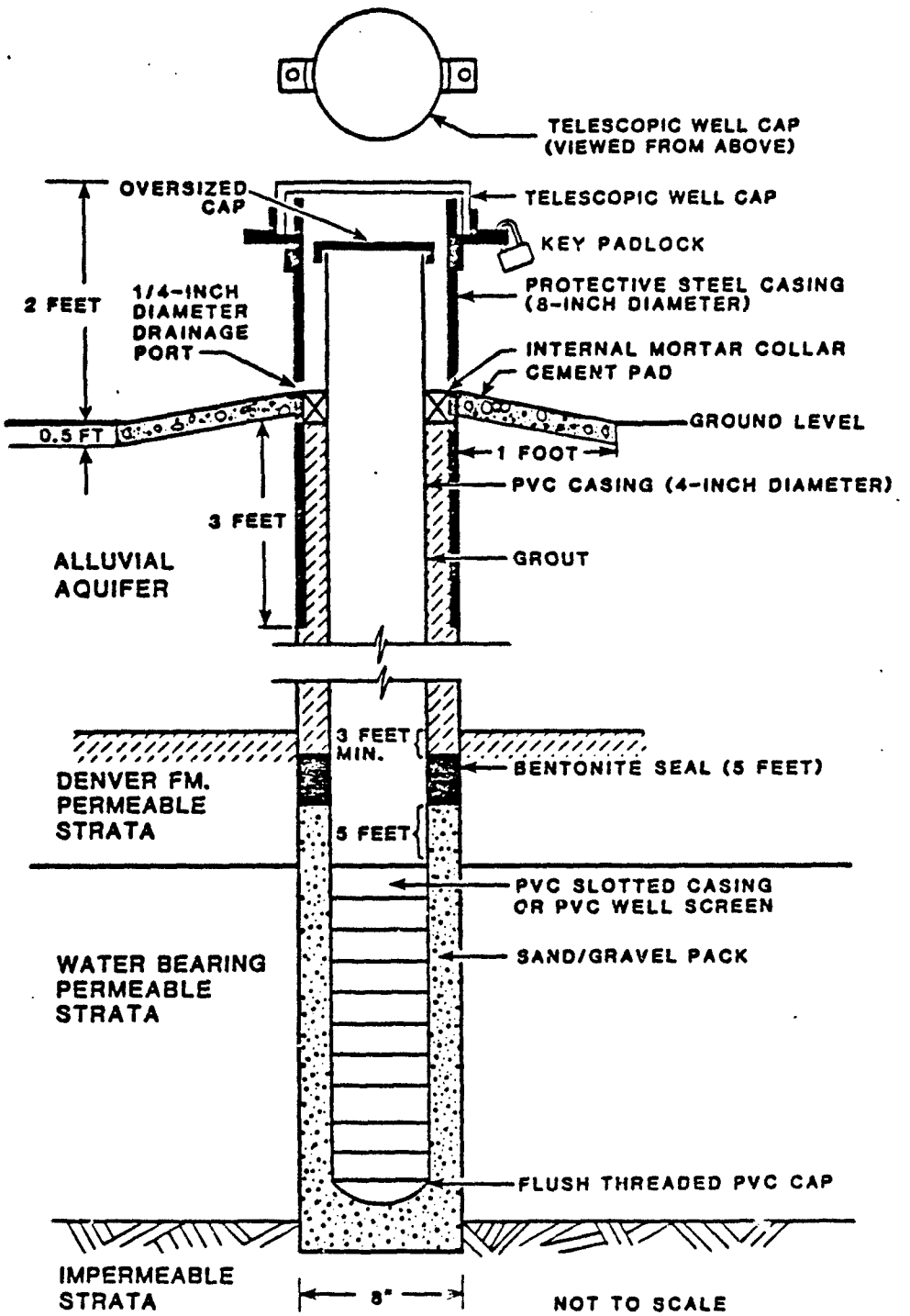
Aberdeen Proving Ground, Maryland



SOURCE: ESE, 1985

Figure 5
DEEP (DENVER FORMATION) MONITOR WELL CONSTRUCTION

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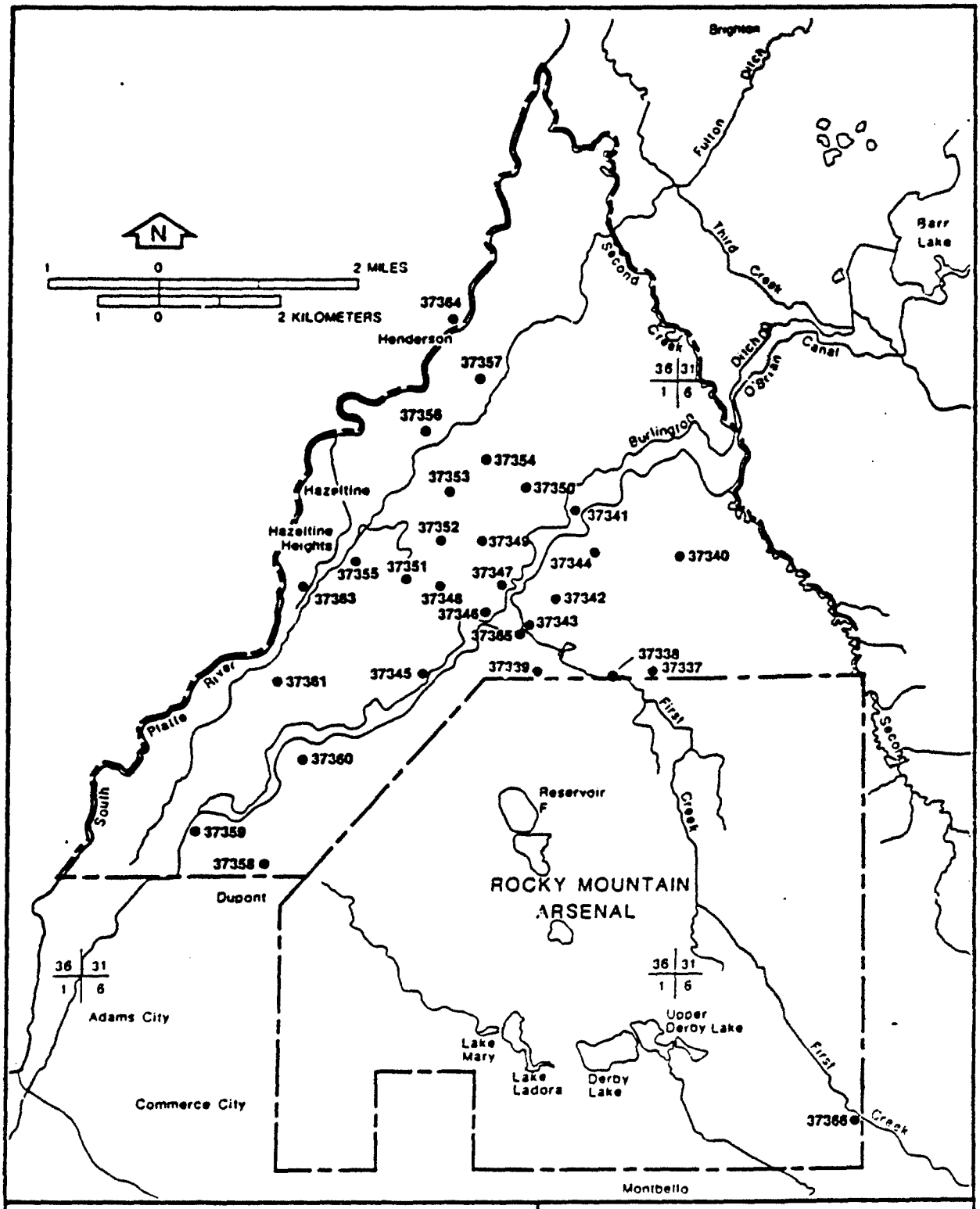

Figure 6
LOCATION OF OFFPOST CONTAMINATION ASSESSMENT MONITORING WELLS (E-SERIES)

SOURCE: ESE, 1986

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

Table 5. Revision III-360° Program--Offpost Contamination Assessment Monitoring Wells

Site ID Number	Well Number	Location Coordinates UTM Zone 13 North	East	Aquifer	Ground Level Elevation	Well Completion Depth (ft BGL[a])	Screened Interval (ft BGL)	Depth to Bedrock (ft BGL)
37352	E-01	4,615,626.447	510,919.506	Alluvium	5072.98	38.3	12.9-38.3	37.9
37340	E-03	4,615,152.914	514,756.525	Alluvium	5135.34	34.1	23.5-34.1	32.0
37350	E-04	4,616,634.983	512,257.354	Alluvium	5077.63	52.3	26.9-52.3	52.3
37357	E-05	4,618,045.177	511,395.808	Alluvium	5021.74	19.7	4.5-19.7	19.0
37341	E-06	4,616,060.041	513,133.480	Alluvium	5100.28	50.7	20.3-50.7	48.7
37338	E-07	4,613,223.465	513,945.526	Alluvium	5134.54	27.8	6.8-27.8	23.5
37337	E-08	4,613,221.309	514,280.638	Alluvium	5167.87	45.2	34.5-45.2	42.5
37339	E-09	4,613,218.374	512,347.635	Alluvium	5135.54	22.3	11.7-22.3	20.0
37342	E-10	4,614,476.569	512,712.364	Alluvium	5116.98	29.0	12.9-29.0	27.5
37343	E-11	4,614,030.556	512,315.467	Alluvium	5110.98	35.1	3.7-35.1	35.5
37347	E-12	4,614,830.448	511,940.141	Alluvium	5101.97	33.8	23.2-33.8	33.5
37345	E-13	4,613,216.888	510,686.594	Alluvium	5101.97	37.1	16.4-37.1	37.5
37346	E-15	4,614,309.689	511,567.678	Alluvium	5096.26	24.1	8.6-24.1	24.0
37353	E-16	4,616,618.972	511,143.555	Alluvium	5069.78	42.4	27.1-42.4	44.0
37348	E-17	4,614,828.379	510,841.788	Alluvium	5082.22	42.0	16.4-42.0	41.0
37354	E-18	4,616,833.638	511,665.461	Alluvium	5055.91	49.1	13.8-49.1	49.0
37349	E-19	4,615,612.480	511,365.064	Alluvium	5081.63	43.6	23.2-43.6	44.0
37364	E-20	4,618,952.602	511,239.298	Alluvium	5008.68	27.3	6.8-27.3	28.9
37351	E-21	4,614,828.199	510,402.033	Alluvium	5076.25	38.5	17.9-38.5	36.0
37356	E-22	4,617,320.226	510,677.032	Alluvium	5025.09	38.4	8.3-38.4	38.5
37355	E-23	4,615,224.012	509,644.009	Alluvium	5053.22	71.7	11.1-71.7	70.0
37365	E-24	4,614,023.670	512,309.183	Denver Formation	5110.37	59.7	49.1-59.7	33.5
37363	E-25	4,614,810.615	508,811.737	Alluvium	5043.85	32.2	6.9-32.2	32.0
37361	E-26	4,613,169.269	508,309.927	Alluvium	5090.55	92.3	21.7-92.3	92.0
37360	E-27	4,611,832.708	508,635.422	Alluvium	5114.68	101.9	26.4-101.9	101.6
37359	E-28	4,610,788.985	507,012.271	Alluvium	5114.71	43.7	23.2-43.7	43.0
37358	E-29	4,610,207.599	508,126.343	Alluvium	5140.25	59.9	44.3-59.9	59.0
37366	E-30	4,605,950.547	517,930.211	Alluvium	5302.64	17.7	2.7-17.7	20.0
37344	E-31	4,615,195.198	513,358.005	Alluvium	5112.53	40.9	15.5-40.9	42.0

BGL - Below Ground Level

Source: ESE, 1986.

In order to further characterize the aquifers in the offpost area, a program of borehole geophysics and aquifer testing will be undertaken at each Offpost CA monitoring well. Geophysical logs will be run in each of the Offpost CA monitoring wells. Natural gamma, neutron, and resistivity logs will provide important stratigraphic information regarding the locations of sands and clays, saturated horizons and porous intervals.

In-situ hydraulic conductivity tests (slug tests) will be performed in all Offpost CA monitoring wells. In a slug test, the water level in a well is lowered or raised essentially instantaneously by adding or removing a known volume of water or inserting or removing a cylinder of known volume. Changes of water level with time are then measured as the well recovers to equilibrium. Water levels will be recorded by use of electronic instrumentation to accurately measure rapid changes. Data from the slug tests will be evaluated using analytical procedures that allow the field conditions to be approximated to the maximum possible extent. These conditions are discussed in detail in the Technical Plan. Hydraulic conductivities calculated from slug test data will be compared to the values determined from grain size analyses and laboratory permeability tests.

SURFACE WATER AND STREAM SEDIMENT SAMPLE STATIONS

During the Revision II-360° Program, offpost surface water samples were collected north of RMA at four locations on First Creek and one location on Second Creek as shown in Figure 7. The network of surface water sampling stations has been expanded to provide a comprehensive assessment of potential contaminants within the offpost study area. Locations of the 11 Revision III-360° Program surface water and stream sediment sample stations are shown in Figure 8. The Revision III sample locations and rationale for selecting these stations are discussed in Section 5.1 of the Technical Plan (ESE, 1985). Flow measurement and sample collection techniques are described in Sections 5.2 and 5.3 of the Technical Plan.

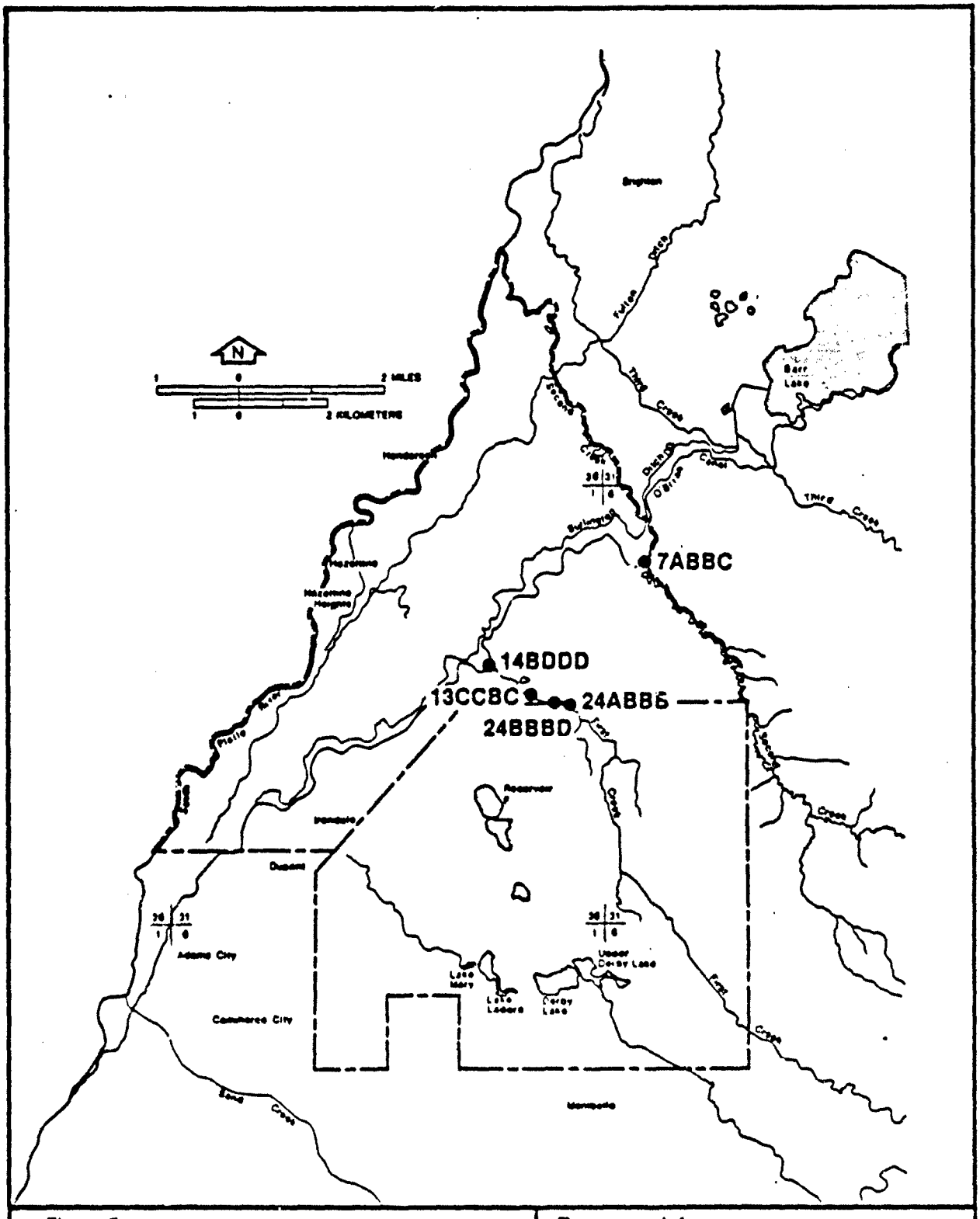

Figure 7
OFFPOST SURFACE WATER
SAMPLING LOCATIONS
REVISION II -360°MONITORING PROGRAM
SOURCE: ESE, 1988

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

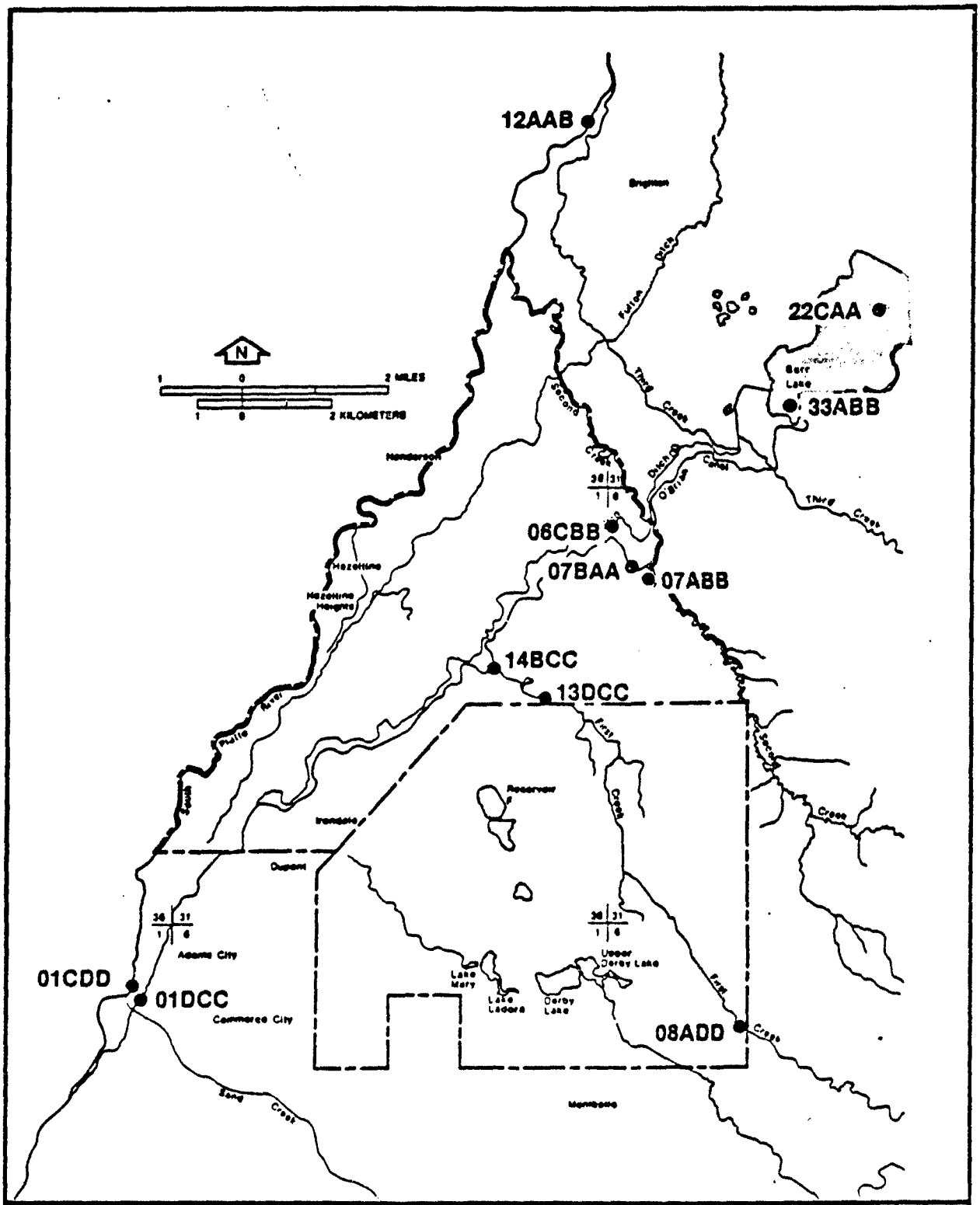

Figure 8
LOCATIONS FOR SURFACE WATER SAMPLING
OFF POST CONTAMINATION ASSESSMENT
REVISION III-360*MONITORING PROGRAM

SOURCE: ESE, 1986

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

REFERENCES

ESE, Inc., 1985a, Rocky Mountain Arsenal Offpost Assessment-Ground Water Quality Report for Sampling Period December 1984 through January 1985.

ESE, Inc., 1985b, Rocky Mountain Arsenal Offpost Contamination Assessment Technical Plan.

ESE, Inc., 1986, Rocky Mountain Arsenal Offpost Assessment-Ground Water Quality Report (Consumptive Use-Phase II) for Sampling Period September 1985 through October 1985.

APPENDIX A

Appendix A. Selected Historical Data—360° Monitoring Program (Page 1 of 6)

Site Identification Number	Well Number	Date	DEHP (µg/g)	DBCP (µg/g)	Aldrin (µg/g)	Dieldrin (µg/g)	Endrin (µg/g)	DCPD (µg/g)	Isodrin (µg/g)	Oxathiane (µg/g)	Dithiane (µg/g)	PCPMS (µg/g)	PCPMSO (µg/g)	$PCPMSO_2$ (µg/g)
37306	OP306	07/12/83	343	<0.2	<0.2	1.38	<0.2	—	<0.2	—	—	—	—	—
37307	OP307	07/12/83	167	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
37308	OP308	02/28/83	243	—	—	—	—	—	—	—	—	—	—	—
		07/13/83	286	<0.2	0.4	7.0	10.0	—	<0.2	—	—	—	—	—
		04/12/84	265	<0.2	<0.2	50.0	<0.2	35.0	<0.2	<20	<20	<20	<20	<20
		07/19/84	175	<0.2	<0.2	<0.2	<0.2	47.0	<0.2	<20	<20	<20	<20	<20
		11/17/84	385	<0.2	<0.2	90.0	<0.2	143.0	<0.2	<20	<20	<20	32.4	<20
		01/17/85	358	<0.2	<0.2	0.95	2.0	—	<0.2	<20	<20	<20	37.8	<20
		04/23/85	202	<0.2	<0.2	0.52	<0.2	—	<0.2	<20	<20	<20	34.3	<20
		07/30/85	128	<0.2	<0.2	0.52	<0.2	—	<0.2	—	—	—	—	—
37309	OP309	02/28/83	766	—	—	—	—	—	—	—	—	—	—	—
		07/13/83	1110	69.0	2.0	40.0	40.0	—	<0.2	—	—	—	—	—
		04/12/84	796	<0.2	<0.2	<0.2	2.49	934.0	<0.2	<20	<20	<20	<20	<30.0
		07/19/84	902	24.0	<0.2	52.0	<0.2	959.0	<0.2	<20	<20	<20	<20	<34.2
		11/17/85	1010	<0.2	<0.2	<0.2	<0.2	1966.0	<0.2	<20	<20	<20	<20	37.5
		01/17/85	922	<0.2	<0.2	<0.2	<0.2	—	<0.2	<20	<20	<20	<20	30.0
		04/23/85	960	<0.2	<0.2	<0.2	<0.2	—	<0.2	<20	<20	<20	<20	30.8
37311	OP311	07/12/83	178	<0.2	<0.2	—	—	—	<0.2	—	—	—	—	—
37312	OP312	07/12/83	190	1.45	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
37313	OP313	07/31/82	6590	<0.2	25.0	<0.2	<0.2	—	<0.2	—	—	—	—	—
		04/12/84	669	<0.2	<0.2	<0.2	<0.2	<1.0	<0.2	<20	<20	<20	<20	<20
		07/19/84	2170	<0.2	<0.2	<0.2	<0.2	—	<0.2	<20	<20	<20	<20	<20
		10/17/84	1820	<0.2	<0.2	<0.2	<0.2	<1.0	<0.2	<20	<20	<20	<20	<20
		01/17/85	4800	<0.2	<0.2	<0.2	<0.2	<1.0	<0.4	<20	<20	<20	<20	<20
		04/23/85	5260	<0.2	<0.2	<0.2	<0.2	<1.0	<0.2	<20	<20	<20	<20	<20
		07/30/85	23.9	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—

Appendix A. Selected Historical Data—360° Monitoring Program (Continued, Page 2 of 6)

Site Identification Number	Well Number	Date	Conductivity (µmho/cm)	pH	Calcium (Ca) (mg/l)	Magnesium (Mg) (mg/l)	Sodium (Na) (mg/l)	Potassium (K) (mg/l)	Alkalinity (mg/l)	Sulfate (SO_4) (mg/l)	Chloride (Cl) (mg/l)	Fluoride (F) (mg/l)	Nitrate (NO_3) (mg/l)	Hardness (mg/l)
37306	OP306	07/12/83	—	—	—	—	—	—	—	—	141.0	3.20	—	—
37307	OP307	07/12/83	—	—	—	—	—	—	—	—	275.0	34.35	—	—
37308	OP308	07/13/83	—	—	—	—	—	—	—	—	287.0	2.88	—	—
		04/12/84	—	—	—	—	—	—	—	—	266.0	3.07	—	—
		07/19/84	—	—	—	—	—	—	—	—	166.0	3.10	—	—
		11/17/84	—	—	—	—	—	—	—	—	294.0	5.00	—	—
		01/17/85	—	—	—	—	—	—	—	—	260.0	3.20	—	—
		04/23/85	—	—	—	—	—	—	—	—	185.00	3.00	—	—
37309	OP309	04/13/83	—	—	—	—	—	—	—	—	468.00	4.9	—	—
		07/13/83	—	—	—	—	—	—	—	—	687.00	3.5	—	—
		07/19/84	—	—	—	—	—	—	—	—	486.00	6.0	—	—
		11/17/84	—	—	—	—	—	—	—	—	853.00	5.0	—	—
		01/17/85	—	—	—	—	—	—	—	—	764.00	5.0	—	—
		04/23/85	—	—	—	—	—	—	—	—	484.00	6.0	—	—
		07/30/85	—	—	—	—	—	—	—	—	—	—	—	—
37311	OP311	07/12/83	—	—	—	—	—	—	—	—	271.00	2.46	—	—
37312	OP312	07/12/83	—	—	—	—	—	—	—	—	547.00	2.04	—	—
37313	OP313	07/31/83	—	—	—	—	—	—	—	—	1430	0.76	—	—
		04/12/84	—	—	—	—	—	—	—	—	410	1.12	—	—
		07/19/84	—	—	—	—	—	—	—	—	640	1.10	—	—
		10/17/84	—	—	—	—	—	—	—	—	723	0.90	—	—
		01/17/85	—	—	—	—	—	—	—	—	1290	1.40	—	—
		04/23/85	—	—	—	—	—	—	—	—	722	1.30	—	—

Appendix A. Selected Historical Data—360° Monitoring Program (Continued, Page 3 of 6)

Site Identification Number	Well Number	Date	DEMP (µg/g)	DBCP (µg/g)	Aldrin (µg/g)	Dieldrin (µg/g)	Endrin (µg/g)	DCPO (µg/g)	Isodrin (µg/g)	Oxathiane (µg/g)	Dithiane (µg/g)	PCPMS (µg/g)	PCPMSO (µg/g)	$PCPMSO_2$ (µg/g)
37320	M-40A	07/12/83	50.4	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
		04/12/84	44.5	<0.2	<0.2	<0.2	<0.2	1.0	<0.2	<20	<20	<20	<20	<20
		07/19/84	42.4	<0.2	<0.2	<0.2	<0.2	<1.0	<0.2	<20	<20	<20	<20	<20
		10/17/84	31.9	<0.2	24.0	<0.2	<0.2	<1.0	<0.2	<20	<20	<20	<20	<20
		01/11/85	30.0	<0.2	0.22	<0.2	0.29	--	<0.2	<20	<20	<20	<20	<20
		04/12/85	32.0	0.3	<0.2	<0.2	<0.2	—	<0.2	<20	<20	<20	<20	<20
		07/30/85	29.8	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
37332	OP332	06/29/83	<10	<0.2	1.14	<0.2	<0.2	—	1.28	—	—	—	—	—
		09/21/83	<10	<0.2	<0.2	0.33	<0.2	—	<0.20	—	—	—	—	—
		12/13/83	<10	<0.2	<0.2	0.82	<0.2	—	<0.20	—	—	—	—	—
		03/27/84	55.6	0.81	<0.2	<0.20	<0.2	—	<0.20	—	—	—	—	—
		06/06/84	50.0	<0.2	0.7	0.70	<0.2	—	<0.20	—	—	—	—	—
		09/12/84	75.8	<0.2	<0.2	0.40	<0.2	—	<0.20	—	—	—	—	—
		12/14/84	100	<0.2	<0.2	0.25	<0.2	—	<0.20	—	—	—	—	—
37333	OP333	06/28/83	<10	<0.2	<0.2	<0.2	0.21	—	<0.20	—	—	—	—	—
		09/21/83	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		12/13/83	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		03/27/84	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		06/06/84	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		09/12/84	11.6	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		12/14/84	10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
37335	OP335	06/28/83	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		09/20/83	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		12/13/83	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		03/27/84	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		06/05/84	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		09/10/84	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—
		12/14/84	<10	<0.2	<0.2	<0.2	<0.2	—	<0.20	—	—	—	—	—

Appendix A. Selected Historical Data—360° Monitoring Program (Continued, Page 4 of 6)

Site Identification Number	Well Number	Date	Conductivity (μmho/cm)	pH	Calcium (Ca) (mg/l)	Magnesium (Mg) (mg/l)	Sodium (Na) (mg/l)	Potassium (K) (mg/l)	Alkalinity (mg/l)	Sulfate (SO_4) (mg/l)	Chloride (Cl) (mg/l)	Fluoride (F) (mg/l)	Nitrate (NO_3) (mg/l)	Hardness (mg/l)
37320	M-40A	07/12/83	—	—	—	—	—	—	—	—	141	0.61	—	—
		04/12/84	—	—	—	—	—	—	—	—	125	1.20	—	—
		07/19/84	—	—	—	—	—	—	—	—	117	1.30	—	—
		10/17/84	—	—	—	—	—	—	—	—	136	1.30	—	—
		01/11/85	—	—	—	—	—	—	—	—	108	1.20	—	—
		04/12/85	—	—	—	—	—	—	—	—	128	1.00	—	—
37332	OP332	06/29/83	—	—	—	—	—	—	—	—	700	3.0	—	—
		09/21/83	—	—	—	—	—	—	—	—	629	3.6	—	—
		12/13/83	—	—	—	—	—	—	—	—	578	4.0	—	—
		03/27/84	—	—	—	—	—	—	—	—	897	<0.20	—	—
		06/06/84	—	—	—	—	—	—	—	—	520	3.00		
		09/12/84	—	—	—	—	—	—	—	—	129	2.90	—	—
		12/14/84	—	—	—	—	—	—	—	—	617	2.90	—	—
37333	OP333	06/28/83	—	—	—	—	—	—	—	—	600	0.30	—	—
		09/21/83	—	—	—	—	—	—	—	—	349	0.65	—	—
		12/13/83	—	—	—	—	—	—	—	—	384	0.60	—	—
		03/27/84	—	—	—	—	—	—	—	—	833	<0.20	—	—
		06/06/84	—	—	—	—	—	—	—	—	440	1.00	—	—
		09/12/84	—	—	—	—	—	—	—	—	129	0.80	—	—
		12/14/84	—	—	—	—	—	—	—	—	433	0.70	—	—
37335	OP335	[illegible]/28/83	—	—	—	—	—	—	—	—	50.0	0.30	—	—
		09/20/83	—	—	—	—	—	—	—	—	111	0.79	—	—
		12/13/83	—	—	—	—	—	—	—	—	118	0.80	—	—
		03/27/84	—	—	—	—	—	—	—	—	103	0.90	—	—
		06/05/84	—	—	—	—	—	—	—	—	150	1.20	—	—
		09/10/84	—	—	—	—	—	—	—	—	103	1.00	—	—
		12/14/84	—	—	—	—	—	—	—	—	99.1	0.90	—	—

Appendix A. Selected Historical Data—360° Monitoring Program (Continued, Page 5 of 6)

Site Identification Number	Well Number	Date	DDMP (µg/g)	DBCP (µg/g)	Aldrin (µg/g)	Dieldrin (µg/g)	Endrin (µg/g)	DCPD (µg/g)	Isodrin (µg/g)	Oxathiane (µg/g)	Dithiane (µg/g)	PCPMS (µg/g)	PCPMSO (µg/g)	$PCPMSO_2$ (µg/g)
37337	E-08	06/29/83	<10	<0.2	<0.2	45.8	25.7	—	0.36	—	—	—	—	—
		09/21/83	<10	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
		12/13/83	<10	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
		03/27/84	<10	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
		06/06/84	<10	<0.2	<0.2	70.0	<0.2	—	<0.2	—	—	—	—	—
		09/12/84	<10	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
		12/11/84	<10	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
		03/13/85	<10	<0.2	<0.2	<0.2	<0.2	—	<0.2	—	—	—	—	—
CIII	CIII	01/25/83	<10	<0.2	—	—	—	—	—	—	—	—	—	—
BOLLER	BOLLER	01/25/83	68.0	0.54	—	—	—	—	—	—	—	—	—	—
		04/26/83	69.2	0.44	—	—	—	<1.0	—	—	—	—	—	—
		07/25/83	70.0	0.53	—	—	—	—	—	—	—	—	—	—
		10/04/83	65.2	0.43	—	—	—	—	—	—	—	—	—	—
		01/24/84	82.4	0.43	—	—	—	—	—	—	—	—	—	—
		04/24/84	89.4	0.50	—	—	—	—	—	—	—	—	—	—
XXI	XXI	01/25/83	<10	<0.2	—	—	—	—	—	—	—	—	—	—
		05/21/84	17.5	<0.2	—	—	—	—	—	—	—	—	—	—
XII	XII	02/22/84	<10	<0.2	—	—	—	—	—	—	—	—	—	—
		05/21/84	<10	<0.2	—	—	—	—	—	—	—	—	—	—

Appendix A. Selected Historical Data—360° Monitoring Program (Continued, Page 6 of 6)

Site Identification Number	Well Number	Date	Conductivity (μmho/cm)	pH	Calcium (Ca) (mg/l)	Magnesium (Mg) (mg/l)	Sodium (Na) (mg/l)	Potassium (K) (mg/l)	Alkalinity (mg/l)	Sulfate (SO_4) (mg/l)	Chloride (Cl) (mg/l)	Fluoride (F) (mg/l)	Nitrate (NO_3) (mg/l)	Hardness (mg/l)
37337	E-08	06/29/83	—	—	—	—	—	—	—	—	100.0	0.90	—	—
		09/21/83	—	—	—	—	—	—	—	—	89.4	1.19	—	—
		12/13/83	—	—	—	—	—	—	—	—	60.6	1.30	—	—
		03/27/84	—	—	—	—	—	—	—	—	70.9	1.40	—	—
		06/06/84	—	—	—	—	—	—	—	—	83.1	1.60	—	—
		09/12/84	—	—	—	—	—	—	—	—	55.8	1.30	—	—
		12/11/84	—	—	—	—	—	—	—	—	55.5	1.20	—	—
		03/13/85	—	—	—	—	—	—	—	—	63.7	1.20	—	—
		06/12/85	—	—	—	—	—	—	—	—	74.9	1.30	—	—
CIII	CIII	01/25/83	1230	7.71	—	—	—	—	248	224	100	0.55	9.8	356
		07/25/83	1230	6.92	82	20	78.6	4.45	193	211	75	0.30	7.0	400
		10/04/83	1060	6.83	103	18.5	75.1	4.62	261	204	87.4	0.54	1.5	237
		01/24/84	1060	6.76	154	21.6	87.6	4.38	283	199	88.7	0.54	0.75	420
		04/24/84	1070	7.02	152	30.0	86.3	5.00	273	186	89.3	0.60	6.0	324
BOLLER	BOLLER	01/25/83	1990	7.67	—	—	—	—	251	660	15	1.20	2.8	600
		04/26/83	—	7.21	—	—	—	—	—	—	—	—	—	—
		07/25/83	2190	7.22	130	2.0	239	2.72	245	683	146	1.00	1.0	700
		10/04/83	1960	7.18	151	51.8	274	3.83	308	580	129	1.39	2.6	425
		01/24/84	2080	7.08	220	64.0	258	3.11	282	672	172	1.28	2.78	632
		04/24/84	2060	7.07	192	80.0	254	4.62	205	500	160	1.30	2.20	594
XXI	XXI	02/18/83	1360	7.16	—	—	—	—	300	220	90	1.30	8.3	390
		05/25/83	1070	7.19	—	—	—	—	243	178	106.2	1.42	3.9	300
		08/26/83	2390	6.88	88.1	32.2	100	3.30	223	164	60	1.58	8.0	178
		11/08/83	1357	6.53	92.6	43.7	124	3.74	338	198	106.9	1.00	8.0	401
		05/21/84	1010	7.22	72.1	36.0	104	3.69	247	146	71.3	1.50	6.0	300
XII	XII	02/22/84	760	7.31	75.6	25.0	110	3.84	247	167	56.7	1.38	10.0	297
		05/21/84	1020	7.17	74.3	36.0	107	4.21	267	147	67.4	1.40	9.0	300

Source: USATHAMA 1983-1985